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Forest Pest Management Report

Technical Report: R10-90-18

Spruce Beetle Activity in Alaska: 1920-1989

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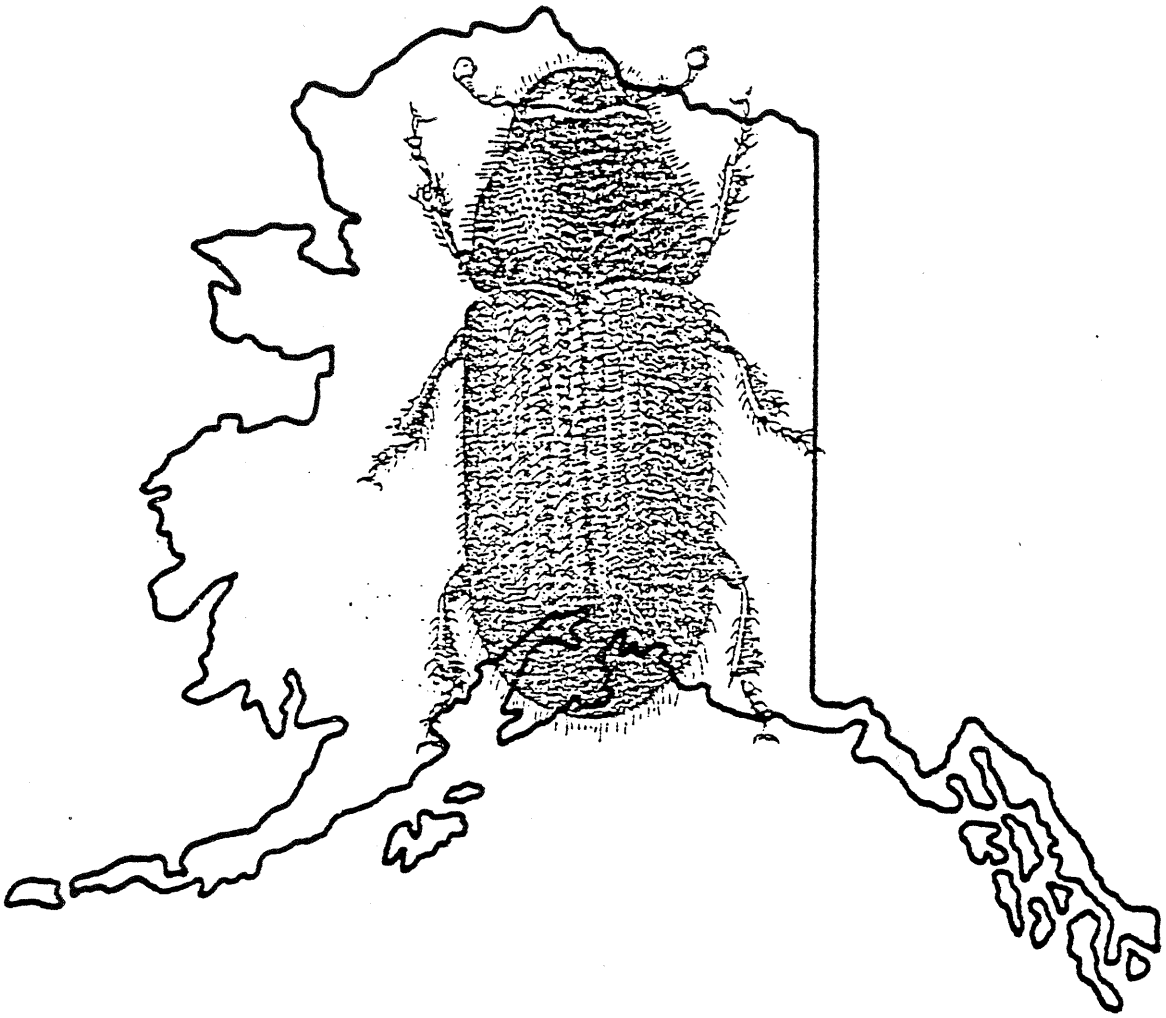

TECHNICAL REPORT R10-90-18
SPRUCE BEETLE ACTIVITY
IN ALASKA
1920-1989

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Prepared by:

Edward H. Holsten, Forest Entomologist
Forest Pest Management
Region 10, Alaska

Approved by:

Gene Lessard, Group Leader
Forest Pest Management
Region 10, Alaska

Dennis Pendleton, Acting Director
State & Private Forestry
Region 10, Alaska

Forest Pest Management
State & Private Forestry
201 E. 9th Ave., Suite 201
Anchorage, Alaska 99501

SPRUCE BEETLE ACTIVITY IN ALASKA, 1920-1989

The most destructive forest insect in Alaska is the spruce bark beetle, *Dendroctonus rufipennis* (Kirby). This insect has killed mature spruce on hundreds of thousands of acres of Alaska's forested lands (Werner et al. 1977). All species of Alaska spruce are susceptible to beetle attack, but black spruce (*Picea mariana*) is rarely attacked.

The occurrence of spruce bark beetle outbreaks and their related impacts have been a common feature of Alaska's forested landscape for decades in south-central Alaska. Statements such as: "It is estimated that in this area at least 60 percent of the spruce is already dead or dying. In a few years green spruce will be hard to obtain, and travel will be more difficult by windfalls resulting from the rotting of the roots of the dead trees. The danger of forest fires will also be increased;" were common in Alaska decades ago (Capps and Tuck 1935).

An on-going infestation of the spruce bark beetle in the Cooper Landing area of the Kenai Peninsula has resulted in public outcry concerning the impact(s) on forest resources resulting from the death of millions of spruce trees. Newspaper articles covering the pro's and con's of spruce beetle outbreaks, impacts, proposed suppression, etc. abound. Statements such as "___an epidemic of spruce bark beetles has swept the Kenai Peninsula, outrunning government efforts to stop its spread around the headwaters of the Kenai River. Officials say the dying forests now pose a fire hazard in the populated canyon_____." (Anch. Daily News, Oct. 25. 1989) have been common in the press recently. We can expect an increase in public awareness of spruce beetle infestations as many of Alaska's spruce forests become more susceptible through the effects of aging, fire suppression, and the lack of management.

Most spruce beetle infestations have, and will continue to occur in the Lutz (*P. X lutzii*) and white spruce (*P. glauca*) stands of south-central Alaska where weather conditions appear to be more favorable for increases in populations of spruce beetles. Outbreaks have been uncommon in the Sitka spruce (*P. sitchensis*) forests of maritime Alaska (Werner et al. 1977). However, results of a recent study (Holsten and Werner 1990) have demonstrated that host suitability may be as important as host susceptibility and weather conditions in the development of spruce beetle outbreaks in Alaska. In terms of progeny production, white spruce as a host produces more beetles than Lutz spruce which is more productive than Sitka spruce. Cold winter temperatures and thrifty fast growing stands have probably helped maintain spruce beetles at endemic levels in interior Alaska. When these factors are ameliorated however, spruce beetle populations can increase rapidly to outbreak levels: a condition which became apparent along the Yukon River in the last five years. Further massive outbreaks can be expected in interior Alaska, especially in forests bordering the major drainages such as the Yukon and the Kuskowkim. In the absence of fire and management, these forests are becoming more susceptible to spruce beetle outbreaks.

Forest pest outbreaks in the United States appear to have increased both in frequency and severity during the last twenty years and Alaska is no exception as spruce beetle outbreaks have increased in severity and occurrence. These pest outbreaks are apparently a symptom of an overall decline in the health of the Nation's forests (USDA For. Serv. 1989). This is not an irreversible trend. Action can and must be implemented on our more important forested lands. Achieving a desired level of productivity, whether productivity is timber, recreation, wildlife or some mix of these resources, generally requires that forest vegetation be alive and healthy. Silvicultural changes are the most important and long lasting, cost effective actions to reduce forest pest impact on the condition of the forest (USDA For. Serv. 1989). On those lands where economics and other societal values allow treatment, emphasis must be placed on achieving long-term improvements. We must avoid practices that promote short-term outputs but are detrimental to the forest health. Such practices can have a negative impact on long-term productivity. There is an urgent need for research studies which

delineate the effects (impacts) of bark beetle infestations on such non-timber forest resources as recreation, wildlife and fisheries, and stream flow.

An interesting finding from this review of Alaska spruce beetle infestations is that many areas have been repeatedly infested over the years: Eklutna-1950's&1980's; Tilikakila River 1950's&1980's, Resurrection Creek-1957&1977, Skwentna River-1930's&1989, Willow Creek-1930's&1980's; Tustumena Lake 1950's&1980's; and most of the northern portion of the Kenai National Wildlife Refuge, to name a few. The general result of the early infestations was a reduction in the size of the residual stems because the majority (up to 90%) of all stems greater than 6" in dbh were killed by spruce beetles. Type conversion did not occur in many areas because there were plenty of small spruce remaining (Beckwith and Curtis 1972). It appears that these stands of small spruce became over-stocked and less thrifty with age and again became susceptible to spruce beetle outbreaks. Many of the repeatedly infested areas are undergoing a type conversion as little or no natural spruce regeneration is present. In order to bring these sites back into spruce, some site preparation such as brought about by fire or logging must be undertaken followed by planting. Type conversion has also occurred in mixed hardwood/spruce stands that have been infested. For example, the severe spruce beetle infestation near Tyonek in the 1970's resulted in 65% mortality of all spruce over 5" dbh. Birch became the dominant species in the residual stand (Baker and Kemperman 1974).

The following summaries present a brief, but complete overview of all documented spruce bark beetle infestations in Alaska presented by year and general location. Outbreaks are grouped into three geographic areas: (1) Interior Alaska -- those forested areas north of the Alaska Range; (2) South-central Alaska which encompasses the Kenai Peninsula and other forested areas south of the Alaska Range excluding the Sitka spruce forests which are placed in the (3) Maritime Region which includes the forests of southeast Alaska, Prince William Sound, and portions of Cook Inlet. Factors contributing to the genesis of a spruce bark beetle outbreak, location of the outbreak, acreage infested, and impact(s) of the outbreak are discussed if available from the literature. A brief discussion of spruce beetle biology, tree hosts, population dynamics, and impacts, etc. is presented in Appendix A. A summary of all outbreaks by geographic location is presented in Table 1 at the end of this report. The bibliography concluding this report lists, by year, the majority of Alaska reports, publications, etc. pertaining to the spruce bark beetle.

SUMMARIES BY YEAR AND LOCATION

1920-1930

SOUTH-CENTRAL: The first recorded Alaska spruce beetle outbreak occurred in white spruce stands along the Copper River drainage between Chitina and McCarthy. The outbreak started in the early 1920's and by the mid-1920's covered more than 200,000 acres (Moffit 1922). The cause of the outbreak is not known but may have been related to drought and logging activities associated with the Kennecott Copper development (Fig. 1a).

1931-1940

SOUTH-CENTRAL: USGS geological survey parties described wide-spread white spruce mortality northwest of Anchorage (Capps 1935, Capps and Tuck 1935). Large spruce beetle outbreaks occurred in the late 1920's to the early 1930's along the Skwentna and Susitna Rivers and in the Willow Creek/Kashwitna area during the early 1930's (Fig. 1b).

MARITIME: A large spruce bark beetle outbreak infested more than 100,000 acres of Afognak Island's Sitka spruce forests in the 1930's (Williams 1933). The outbreak was over by the mid-1940's (Furniss 1948). Areas most heavily impacted included Blue Fox Bay, along Kupreanof Straight, and Whale Island. A 1933 timber inventory estimated that 23% of the spruce had been killed with mortality amounting to 149,679,000 board feet (bf) over 107,776 acres (Williams 1933). The cause of the outbreak is not known (Fig. 2a).

1941-1950

SOUTH-CENTRAL: Scattered mortality of white spruce was noted in 1950 in trees bordering the Kenai Burn of 1947 (Furniss 1950). Spruce beetles had attacked and bred in fire scorched trees then moved into nearby green trees (Fig. 1b).

Spruce beetle activity was apparent in 1947 along the lower slopes on the southeast side of Knik Arm between Anchorage and the Knik River crossing (Furniss 1950). Beetle populations apparently increased in fresh blowdown near Eagle River and Chugiak as well as in logging slash near Eagle River.

MARITIME: From 1940-1948, a spruce bark beetle outbreak occurred in the Edna Bay area of Kosciusko Island located in southeast Alaska. Considerable mortality also occurred on Bluff and Barrier Islands (Furniss 1946, Furniss and Jones 1946). The outbreak was possibly caused by a combination of factors including blowdown, overmature low-vigor spruce growing on shallow, dry soils. Approximately 50,000,000 bf of high value Sitka spruce was killed over 6,400 acres (Fig. 2b).

INTERIOR: Increasing mortality of white spruce caused by the spruce beetle was first reported in 1943 from the Haines cut-off area (Hughes 1948) during construction of the Haines Cut-off Highway. Spruce mortality averaged 50% in stands from mile 89 northward to the south end of Dezadeash Lake

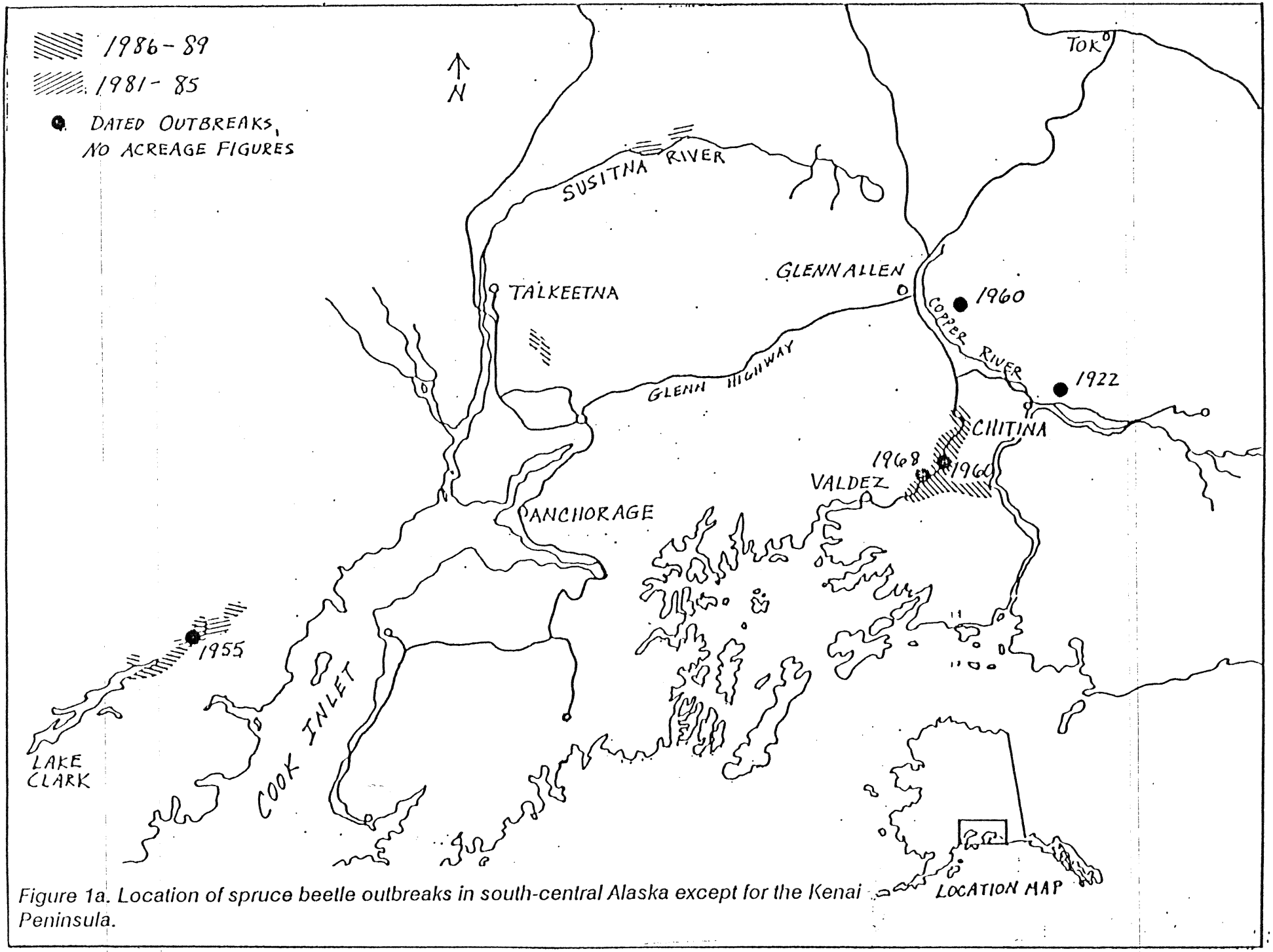

Figure 1a. Location of spruce beetle outbreaks in south-central Alaska except for the Kenai Peninsula.

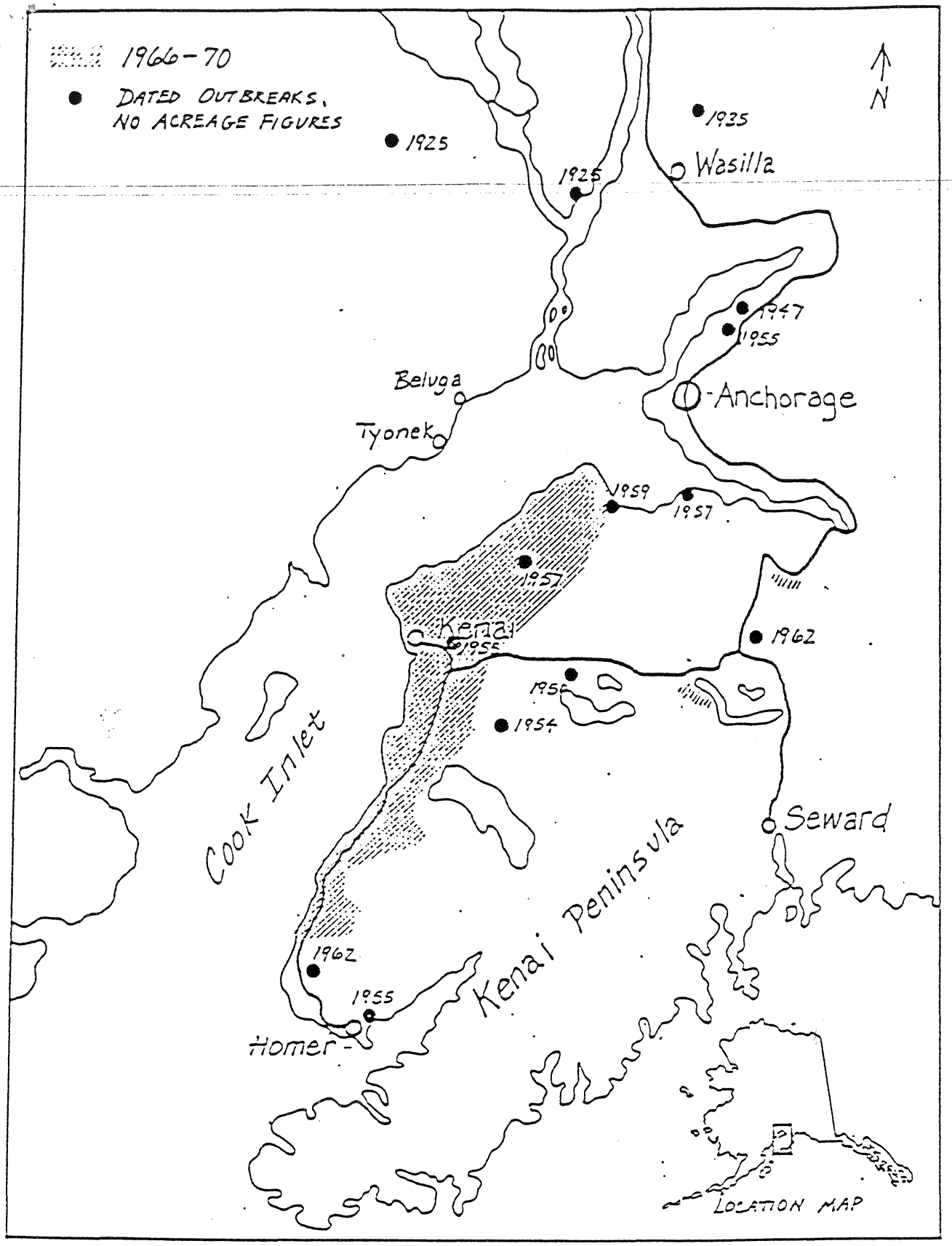

Figure 1b. Location of spruce beetle outbreaks in south-central Alaska up to 1970; specifically on the Kenai Peninsula.

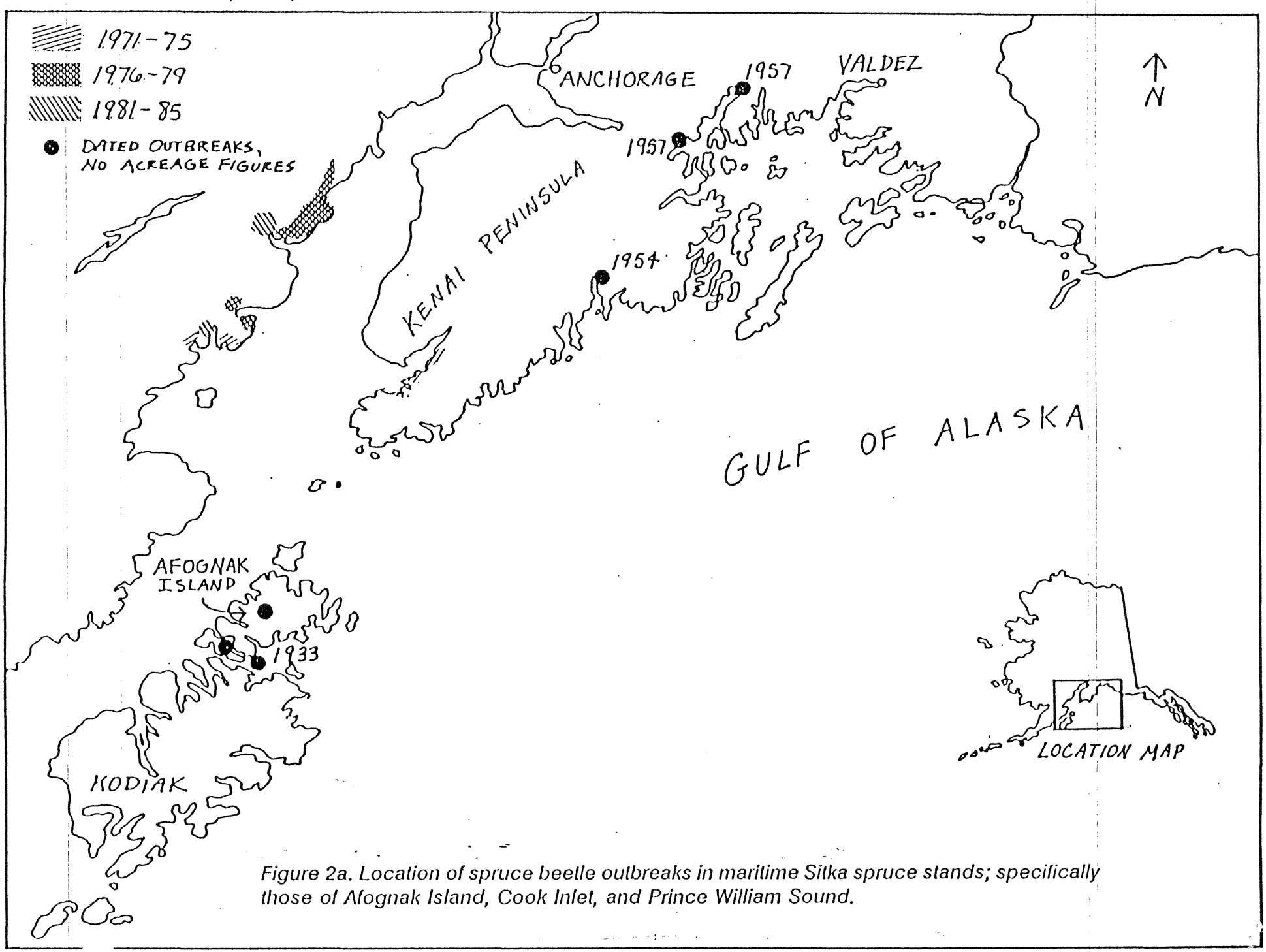

Figure 2a. Location of spruce beetle outbreaks in maritime Sitka spruce stands; specifically those of Afognak Island, Cook Inlet, and Prince William Sound.

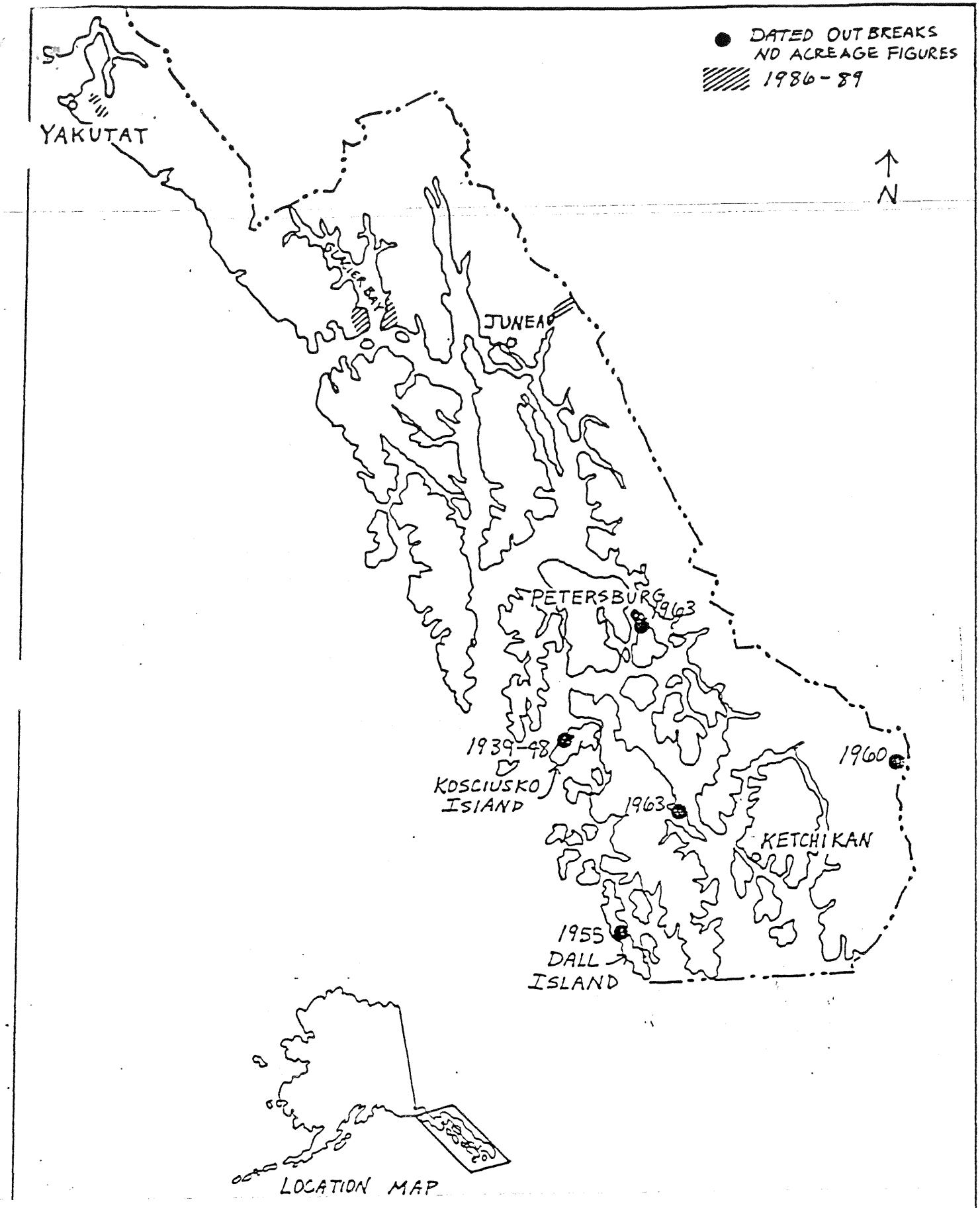

Figure 2b. Location of spruce beetle outbreaks in southeast Alaska's maritime Sitka spruce stands.

(Canada) at mile 127 then northeasterly towards Champagne, Y.T., Canada. The infestation barely made it into Alaska and caused little mortality.

1951-1955

SOUTH-CENTRAL: Spruce bark beetle activity was reported (McCambridge 1954) from the vicinity of Skilak and Tustumena Lakes; no acreage figures were given. A 1954 ground check indicated that wood pecker and parasite activity were quite high and spruce beetle populations were declining. Powerline and road construction were undertaken near Soldotna and Homer and large quantities of slash were left on the ground. Spruce beetle populations apparently increased in this material and began attacking and killing standing live spruce at a light, but steady rate (McCambridge 1955) (Fig. 1b).

Infested spruce were once again apparent northeast of Anchorage in 1955. The scattered outbreak (single trees or small groups) encompassed several thousand acres in the vicinity of Eklutna (McCambridge 1955) (Fig. 1b).

An on-going spruce beetle outbreak was detected in white spruce stands near Lake Clark (McCambridge 1955). Extensive areas of previous beetle activity as well as current tree mortality were observed along the Tlikakila River, NE of Lake Clark. The infestation was scattered over 100,000 acres in 1955 and declining (Fig. 1a).

MARITIME: A small number of standing infested Sitka spruce were observed in 1954 near the Bear Lake logging operation near Seward (McCambridge 1955). This spruce beetle activity declined in the following years (Fig. 2a).

1955 aerial detection surveys noted pockets of recent spruce beetle activity on the south side of Port Bazan on Dall Island (McCambridge 1955). This outbreak lasted from 1952-1957 and impacted 200 acres of Sitka spruce resulting in a volume loss of 1.5 million bf (500 trees killed each averaging 3,000 bf)(Downing 1956 a,b). Salvage logging was promptly undertaken (Fig. 2b).

1956-1960

SOUTH-CENTRAL: Spruce bark beetle activity increased on portions of the Kenai Peninsula in the late 1950's. Several small outbreaks were detected in 1957 on the Chugach National Forest (CNF) near the east fork of Sixmile Creek and mid-way up the Resurrection Creek (Downing 1957). Elsewhere on the Kenai, bark beetle activity was noted along the shore on the east side of Chickaloon Bay and mid-way up the Swanson River on the Kenai National Moose Range (KNMR). Losses within the KNMR were in close proximity to a large burned-over area (Fig. 1b).

Bark beetle activity on the CNF increased in 1958 with infestations noted along Resurrection Creek, Palmer Creek, Granite Creek, Quartz Creek. Losses were expected to be high in 1959 (USDA For. Serv. 1958). As expected, spruce beetles caused heavy losses of white and Lutz spruce on portions of the Kenai Peninsula (Downing 1959). Specifically, infestations covered approximately 16,000 acres of the CNF in the following areas: Quartz Creek-Summit Lake, Granite Creek, Resurrection and Palmer Creek. Control of the outbreaks through salvage logging and chemical measures was considered. A larger, scattered infestation covering tens of thousands of acres was located on the northern portion of the KNMR extending from Chickaloon River on the east to Moose Pt. on the west and north to Pt. Possession (Downing 1959). Infestations did not increase in size in 1960 on the Kenai but intensified

(Downing 1960). Two new spruce beetle outbreaks however, were detected near Copper Center; one along the Little Tonsina River and the other on the east side of the Copper River. Several thousand trees were killed and the outbreak was expected to continue (Downing 1960) (Fig. 1b).

North of Anchorage, losses due to bark beetles declined in 1957 along the Matanuska River and the southeast side of Knik Arm.

MARITIME: A spruce beetle infestation in Sitka spruce stands bordering Blackstone Bay near Whittier was detected in 1957. This two thousand acre outbreak had been on-going since 1952 (Downing 1957). Another smaller (500 acre) outbreak was detected along Pt. Pakenham in the College Fjiord area of Prince William Sound. Both outbreaks declined in 1958 (USDA For. Serv. 1958) (Fig. 2a).

1961-1965

SOUTH-CENTRAL: Bark beetle activity was static in 1961 (Crosby 1961) but increased in 1962 on the Kenai Peninsula (Crosby 1962). Two new hot spots were detected: one near Anchor Point and the other about 40 miles north of Seward. It was estimated that there would be a 2- to 3-fold increase in numbers of newly attacked trees in 1963. Also, recent (1962) beetle infested spruce were detected in the Copper River area near Chitinia. The increases in spruce beetle populations expected in 1963 failed to materialize and by 1965, spruce beetle populations were at low, endemic levels throughout the State (Crosby 1963, 1964, 1965). No active beetle infestations were noted from either aerial survey or highway reconnaissances (Fig. 1a,b).

MARITIME: Spruce beetle activity was reported in 1963 from central Prince of Wales Island and from a point near Petersburg (Crosby 1963). Only a few trees were attacked in each area. Several areas of recent Sitka spruce blowdown in southeast Alaska failed to produce the expected build-up of spruce beetle populations (Fig. 2b).

1966-1970

SOUTH-CENTRAL: The late 1960's was a period of rapid expansion of spruce bark beetle outbreaks on the Kenai Peninsula. Patches of tree mortality occurred in a variety of areas of the CNF in 1966: west shore of Kenai Lake, junction of the Russian and Kenai Rivers, and near Jerome Lake. The use of trap trees as a control measure for the suppression of spruce beetle populations was contemplated for a section of Snug Harbor Road where infestations were increasing due to large amounts of breeding material (scorched spruce) from the 1959 Kenai Lake Burn (Crosby 1966, Galea 1968). Elsewhere on the Kenai spruce beetle populations increased. Considerable tree mortality was observed in 1966 on 100 acres near the mouth of Chickaloon River and further south on the Kenai Peninsula near Anchor Point. The Chickaloon River infestation within the Moose Range extended its borders noticeably during 1967 and by 1969 bark beetle populations covered 40,000 acres from Pt. Possession to Homer. A continuation of drought conditions had provided the catalyst for numerous minor outbreaks created by a succession of land clearing, petroleum exploration and various right-of-way activities to erupt into the present major epidemic (Crosby and Curtis 1969). By 1970 two hundred thousand acres were infested on the KNMR with and additional 60,000 infested acres on State and private lands accounting for more than a billion bf of spruce mortality. The spruce beetle infestation extended almost unbroken from Pt. Possession to Clam Gulch with two smaller outbreaks occurring in the Deep Creek drainage near Ninilchik. This major outbreak expanded from a minor outbreak of less than 100 acres in 1966

into a major epidemic covering more than four townships (USDA For. Serv. 1970, Curtis 1970) (Fig. 1b).

Bark beetle activity likewise increased in the late 1960's on portions of the CNF: a high incidence of bark beetle activity was observed in 1967 in the Granite Creek area. Scattered spruce mortality had been noted in this area since 1957. Approximately 1,300 acres of infested spruce occurred between East Fork River and the Granite Creek Guard Station (Crosby 1967). An eight acre stand of spruce was infested around a proposed Forest Service Campground near Juneau Falls. A 400 acre hot spot within the 1,300 acre Granite Creek/East Fork infestation was treated with a combination of trap trees and chemicals (Crosby and Curtis 1968). By 1969, spruce beetle populations were subsiding on the CNF. Another 300 acres of the Granite Creek infestation were treated (Crosby and Curtis 1969). Spruce beetle population build-up was detected in 1970 in the 1969 blowdown which occurred in the Six Mile area, Resurrection Creek drainages and in the Summit Lake area. Likewise, spruce beetle populations were increasing around the edges of the 1969 Russian River Burn (USDA For. Serv. 1970, Curtis 1970) (Fig. 1b).

Spruce mortality was observed in 1968 on 200 acres along Caribou Creek near mile 108 of the Glenn Highway. Likewise, increased tree killing was observed on scattered over-mature spruce along the east side of the Tonsina River in the vicinity of Stuart Creek (Crosby and Curtis 1968); beetle populations declined in both areas by 1970 (Fig. 1a).

The 1969 drought conditions as well as land clearing practices resulted in increased spruce beetle population build-up causing heavy tree killing of white spruce in suburban Anchorage areas. Similar conditions occurred in the white spruce stands between Palmer and Eureka (Crosby and Curtis 1969).

MARITIME: The only documented spruce beetle activity occurred in 1968 along a five mile stretch of the Salmon River at the head of Portland Canal in southeast Alaska. Two hundred acres of river bottom Sitka spruce were killed by spruce beetles. The infested timber was probably pre-disposed to beetle attack by prior flooding and subsequent damage to tree roots. Salvage logging was employed (Crosby and Curtis 1968) (Fig. 2b).

1971-1975

SOUTH-CENTRAL: The early 1970's saw an overall decline of spruce beetle activity on the Kenai Peninsula and a dramatic increase in infestations on the west side of Cook Inlet. Increased activity however, was noted on the eastern edge of the Moose Refuge where 400 acres along Mystery Creek were infested. The anticipated build-up of spruce beetle populations in portions of the CNF did not materialize. The 700 acre treatment area in the Granite Creek area was effective as no new infestations were detected in 1971 (Curtis and Swanson 1972) (Fig. 1c).

Spruce beetle populations in 1972 started to decrease on the northern half of the Kenai Peninsula following six years of outbreaks. These outbreaks followed several years of drought. Rainfall within the infested area was below the long-term average for six of the ten years from 1961-1970. The general result of this infestation was a reduction in size of the residual stand. Type conversion had not occurred as there were plenty of small size spruce (Beckwith and Curtis 1972). The most serious outbreak in progress on the Kenai Peninsula was occurring south and west of Tustumena Lake from Clam Gulch to the Anchor River. Tree killing was reported scattered over 60,000 acres (Baker and Curtis 1972) (Fig. 1c).

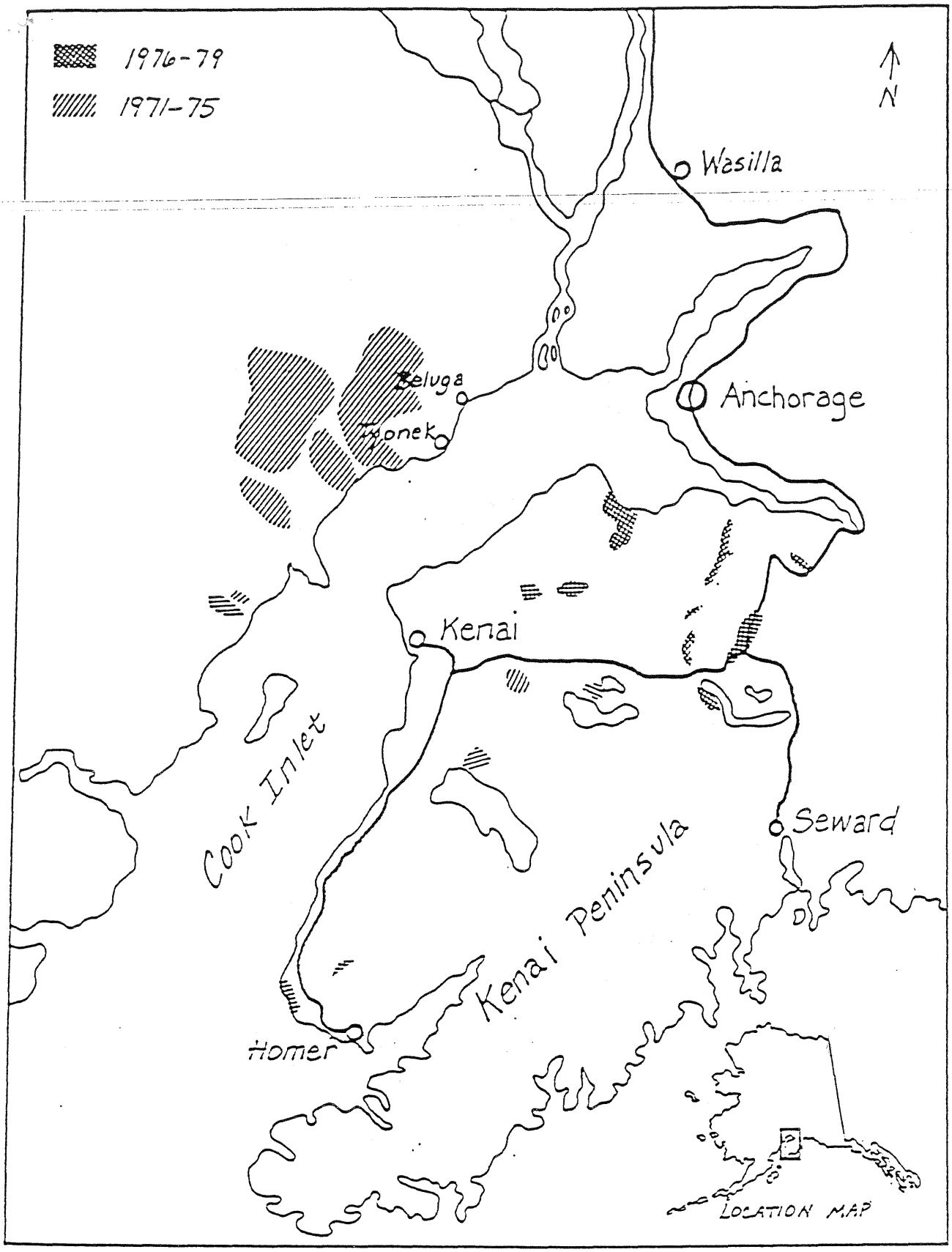

Figure 1c. Location of spruce beetle outbreaks from 1971-1979 in south-central Aleska; specifically on the Kenai Peninsula and the west side of Cook Inlet.

Spruce beetle populations were generally at low levels on the CNF with localized patches of spruce mortality occurring near Canyon and Granite Creek drainages (Baker and Curtis 1972). Spruce beetles continued to breed in patches of blowdown along Resurrection Creek (Fig. 1c).

A "new" large outbreak was detected in 1972 on the west-side of Cook Inlet where more than 70,000 acres of spruce mortality occurred near Trading Bay and Tyonek. This outbreak appeared to be in progress for 3-4 years. The cause of the outbreak was not definitely known but was believed to be associated with seismic line clearing debris from 1965-68 and the severe drought of 1968-69.

The Tyonek infestation impacted 103,000 acres in 1973. The Alaska State Division of Lands initiated a salvage sale near Tyonek that covered 223,000 acres with a total of 425 mm bf of mixed species (spruce 285 mm bf). Bark beetle populations continued to decline on the Kenai Peninsula where only 53,000 acres of active infestations were noted (Baker and Laurent 1974).

Spruce beetle caused tree mortality was concentrated in 1974 near Beluga Lake on the west-side of Cook Inlet and impacted an additional 140,000 acres. Tree killing was expected to intensify along the Beluga River in 1975. The Kenai Peninsula outbreaks declined further in 1974-no significant infestations were observed (Baker et al. 1975). The following table summarizes recent Cook Inlet spruce beetle outbreaks (in acres) (Baker et al. 1975):

	KENAI PENIN.	W. COOK INLET	TOTAL
Late 60's thru 1973	253,700	120,600	374,300
1974	300	143,400	143,700
TOTAL	254,000	264,000	518,000

Assuming an average gross volume of 4,500 bf per acre, spruce beetles caused more than two billion board feet of spruce mortality.

The spruce beetle remained in outbreak status on the west-side of Cook Inlet in 1975 with infestations totalling 167,000 acres. Population levels were expected to decline in 1976 (Hostetler et al. 1976). Of the estimated 425 mm bf of timber in the Tyonek Sale; 88 mm of spruce was cut and decked by Dec. 1975. An estimated additional 25 mm bf of spruce and 20 mm of hardwoods had been cut. Spruce beetle populations on the Kenai Peninsula remained at low levels in 1975 with a few small scattered populations (Fig. 1c).

MARITIME: Five to six thousand acres of infested Sitka spruce were detected in 1972 on BLM lands along the southwest shore of Cook Inlet near Mt. Iliamna (Baker and Curtis 1972). Infested areas were adjacent to several patches of blowdown which occurred in 1967-68. This infestation subsided by 1974. In southeast Alaska, forty Sitka spruce were killed by spruce beetles in Saw Mill Creek Campground near Sitka. These trees were previously defoliated by the spruce aphid possibly predisposing them to spruce beetle attacks (Baker and Curtis 1972) (Fig. 2a).

1976-1980

SOUTH-CENTRAL: Spruce beetle activity decreased in 1976 on the west side of Cook Inlet; of the 167,000 acres of active infestations reported in 1975, only scattered spots remained in 1976. Most of the activity was confined to an area east of Lone Ridge, nw of Tyonek. Spruce beetle activity remained

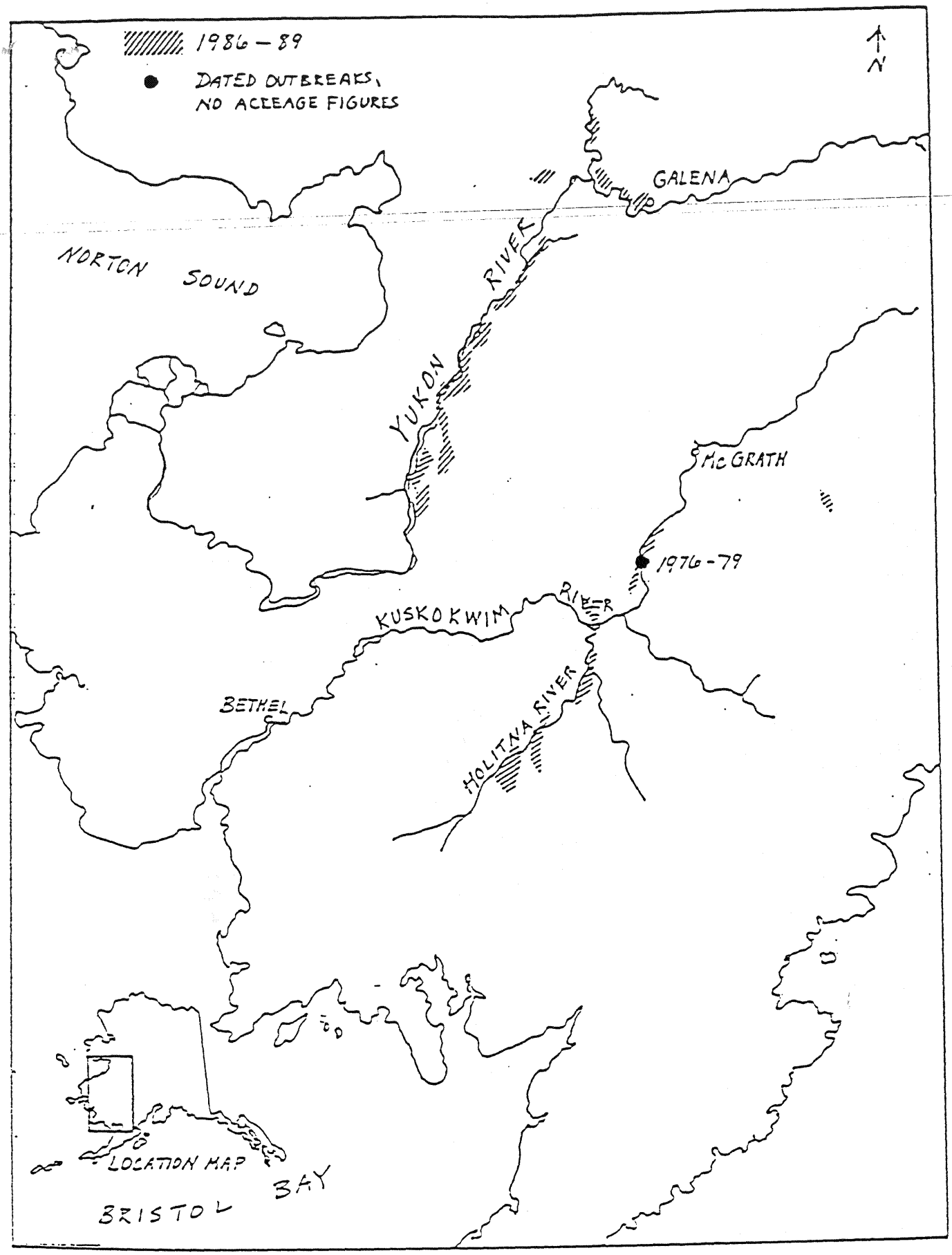

Figure 3. Location of spruce beetle outbreaks in interior Alaska's white spruce stands.

at low levels on most of the Kenai Peninsula. Increased spruce mortality however, was detected in 1976 on almost 8,000 acres along the Resurrection Creek drainage of the CNF. This increased mortality is a result of beetle populations breeding in the extensive windthrow of 1974 and 1975 (Rush et al. 1977). The Resurrection Creek outbreak increased in 1977 by 5,000 acres and encompassed 12,830 acres (USDA For. Serv. 1978). Spruce beetle caused tree mortality on the CNF increased by 18% over 1977 levels. Much of this increase occurred in the Summit Lake area where more than 3,000 acres of spruce were infested. Close to 1,000 acres of spruce forests were impacted near Upper Russian Lake (USDA For. Serv. 1979) (Fig. 1c).

Elsewhere on the Kenai Peninsula spruce beetle populations increased: 47,000 acres were infested throughout the Moose Range in 1978. The heaviest impacted area was near Barabara Lake (7,620 acres).

Spruce beetle activity on the west side of Cook Inlet increased in 1978; 64,000 acres of very light (less than 0.25 trees/acre) spruce mortality was detected near Lower Beluga Lake. As of October 1978, a total of 58.9 mm bf of spruce had been harvested on the Westside Salvage Sale (USDA For. Serv. 1979).

Spruce beetle populations exploded and by 1979/80 infestations covered approximately 380,000 acres throughout the State. This was an increase of 250,000 acres over 1978 levels (USDA For. Serv. 1980, 1981). Mortality was apparent on the CNF where 33,098 acres were infested. The Summit Lake infestation increased by 50% and covered 13,924 acres; the Resurrection Creek infestation had increased to 15,240 acres. Elsewhere on the Kenai, spruce beetle populations increased: Barabara Lake area-12,162 acres; west of Tustumena Lake-19,698 acres. Infestations on west side of Cook Inlet covered approximately 374,452 acres north of Beluga Lake (Fig. 1c).

MARITIME: For the first time in many years, Sitka spruce mortality was detected in 1980 on 1,000 acres in southeast Alaska; areas most heavily impacted were along the Taku River near Juneau. The infestation appeared to be about three years old; probably originating near Klackman Mountain (USDA For. Serv. 1981). Scattered groups of spruce beetle infested spruce were detected along the south-west shore of Kachemak Bay across from Homer on the Kenai Peninsula (Fig. 2a,b).

INTERIOR: The only spruce beetle impacted areas occurred in the white spruce stands along the Kuskokwim River. Light spruce beetle activity was detected on 2,600 acres 15 miles south of Devil's Elbow in 1978 (USDA For. Serv. 1979). The Devil's Elbow outbreak declined in 1979. Infestations (4,000 acres) then increased five miles northeast of Little Russian Mission (USDA For. Serv. 1980). Spruce beetle activity decreased by 50% in 1980; only 2,481 acres of scattered infested spruce were aerially detected along the Kuskokwim River (Fig. 3).

1981-1985

The early 1980's experienced increased spruce beetle activity in southeast and south-central Alaska. Little activity was detected in the interior.

SOUTH-CENTRAL: Spruce beetle populations infested 490,220 acres in 1982 vs. 240,000 acres in 1981. The increase was most apparent in the Beluga Lake area on the west side of Cook Inlet. New infestations were detected in 1982 on 49,291 acres of white spruce along both sides of the Susitna River from Devil's Canyon to Gold Creek (USDA For. Serv. 1983).

Infestations on the CNF decreased from 41,051 acres in 1981 to 37,929 acres in 1982. After three years of increase, the Summit Lake infestation declined, and by 1982,extended over 9,924 acres. The Resurrection Creek infestation had not expanded and still affected 15,240 acres. Beetle activity increased in 1981 near Cooper Lake, Mystery Hills, Round Mountain, and other areas near Cooper Landing. Elsewhere on the Kenai, infestations increased: 41,369 vs. 27,303 acres in 1981. The largest increase was detected northeast of Mystery Hills on the Kenai National Wildlife Refuge (KNWR) where 29,688 acres were infested in 1982; a 40% increase over 1981 levels. On the southern end of the Kenai, bark beetle populations were 50% less in 1982 than the 1981 level of 2,560 acres (USDA For. Serv. 1983). Scattered spruce beetle activity was still observed on the southeast side of Kachemak Bay. Heavy spruce beetle activity was noted in 1982 on Kalgin Island; on-going for at least two years (Fig. 1d).

Spruce beetle populations decreased slightly in 1983 but increased by 22% in 1984 and covered 432,603 acres state-wide (USDA For. Serv. 1983, 1984). Bark beetle activity was static on the CNF with the exception of the Resurrection Creek outbreak which expanded in 1983 and encompassed 20,320 acres. 44,745 acres of the KNWR were impacted in 1983; the majority occurring in the Mystery Hills area. Infestations also increased further south on the Kenai Peninsula where 8,344 acres of scattered infestations were aerially detected. Of interest in 1983, 1,524 acres of spruce beetle activity was detected north of Valdez along the Richardson Highway near the confluence of the Tiekel and Tsina Rivers (USDA For. Serv. 1983) (Fig. 1a,d).

By 1984 bark beetle activity increased on the CNF where 56,342 acres were impacted. Intense spruce beetle activity continued on 12,484 acres in the Cooper Landing/Russian River areas-most notably west of Juneau Creek. Other areas on the Chugach appeared to be static or declining. The Mystery Hills outbreak increased dramatically; 53,713 acres of Wildlife Refuge lands were infested north of the Sterling Highway and following Mystery Hills up to and including the Big and Little Indian drainages. Infestations on the southern end of the Kenai Peninsula more than doubled and covered 22,177 acres; the majority (15,690 acres) occurred along the Fox River drainage. The spruce beetle activity detected along the Richardson Highway in 1983 increased to 5,293 acres in 1984. Scattered spruce beetle activity also increased in the Anchorage bowl and Chugiak/Eagle River areas: Ship Creek-3,523 acres; Eklutna Lake-3,597 acres. Beetle activity was aerially detected on 31,509 acres along the Tikakila River near Lake Clark; the same area infested almost 30 years ago. This scattered beetle activity declined by 1985 (Fig. 1a,d).

Spruce bark beetle infestations decreased statewide in 1985 by 40% over 1984 levels; infestations covered covered 255,270 acres. Decreases were most apparent on the CNF and the west side of Cook Inlet. Increased activity however, was still apparent in the Cooper Landing/Russian River areas (USDA For. Serv. 1985). Infestations decreased by 28% on the KNWR but were still evident on 43,326 acres in the Mystery Hills/Skilak Lake areas.

Infestations decreased (63%) on the west side of Cook Inlet where spruce beetle activity was detected on 64,234 acres north of Beluga Lake (USDA For. Serv. 1985). The Richardson Highway outbreak increased; more than 5,000 acres were infested.

MARITIME: The largest increase in spruce beetle activity in Sitka spruce occurred in southeast Alaska in Glacier Bay National Park. This infestation was first detected in 1982 and was apparent on 5,000 acres. It was thought to have been active for four years. The outbreak expanded in 1983 and impacted 6,350 acres (USDA For. Serv. 1983) and by 1985, the outbreak had expanded to the east and north and covered 12,200 acres in the Park (USDA For. Serv. 1985). Other outbreaks in southeast such as the Taku River infestation of 2,000 acres and the Whiting River 900 acre infestation died out (Fig. 2b).

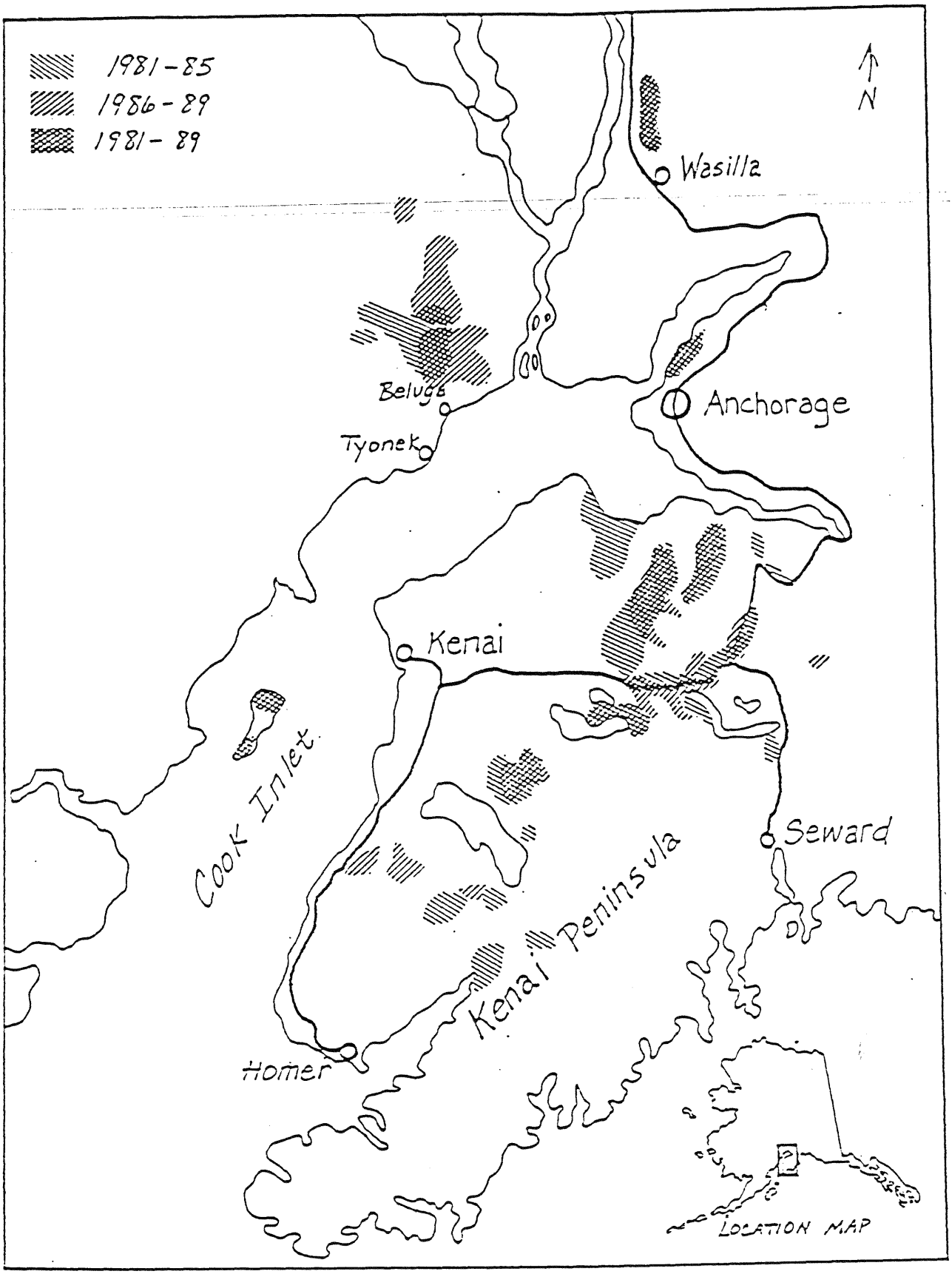

Figure 1d. Location of spruce beetle outbreaks from 1981-1989 in south-central Alaska; specifically on the Kenai Peninsula and the west side of Cook Inlet.

Of interest though, was the detection of 200 acres of Sitka spruce mortality within Kachemak Bay State Park across from Homer on the Kenai Peninsula. This beetle activity was located near Mallard Bay and was associated with nearby spruce windthrow (USDA For. Serv. 1985) (Fig. 2a).

1986-1989

Spruce beetle activity in the late 1980's was most apparent for the first time in interior Alaska's white spruce stands. Populations decreased in south-central and southeast Alaska.

SOUTH-CENTRAL: Spruce mortality continued on 40,423 acres of the CNF in 1986 (USDA For. Serv. 1986). A slight increase in activity was noted in the Cooper Landing/Russian River area. The majority of the KNWR infestations were still occurring north of Mystery Hills. Approximately 10,000 acres of light scattered beetle activity was detected in the Ninilchik River and Crooked Creek areas.

Spruce beetle infestations continued in 1986 on the west side of Cook Inlet where 100,000 acres were impacted nw of Little Mt. Susitna and west of Beluga Mountain. Spruce beetle activity in the Anchorage and Eagle River/Chugiak areas was apparent although decreasing; Fort Richardson lands had 5-10,000 acres of infested spruce. The Tiekel River outbreak along the Richardson Highway covered close to 20,000 acres. Spruce beetle infestations decreased in 1987; decreases most apparent on west side of Cook Inlet and on the CNF (USDA For. Serv. 1987). Activity was still apparent in the Summit Lake, Cooper Landing, and Russian River Campground areas. Spruce beetle activity increased in 1987 by 9,000 acres on KNWR where 63,099 acres were infested; mostly in the Mystery Hills/Skilak Lake area. Infestations declined further south on the Kenai along the Fox River drainage. Spruce beetle activity further declined in the Anchorage/Eagle River areas. The Tiekel River outbreak however, intensified by 3,500 acres and encompassed 23,586 acres (Fig. 1a).

Spruce beetle populations remained static in 1988 although heavy localized infestations were apparent along the road cooridor in the Cooper Landing area and near Upper Trail Lake (USDA For. Serv. 1986). Scattered spruce beetle activity has been apparent for 2-3 years on 41,000 acres southwest of Tustumena Lake. Spruce beetle populations declined further in the Anchorage/Eagle River areas. However, further north of Anchorage spruce beetle activity increased: 14,000 acres were detected south of of the Matanuska River near Kings Mountain; 19,000 acres were detected for the third year between Willow and Little Willow Creek. The Tiekel River outbreak decreased in size (Fig. 1a,d).

Most spruce beetle infestations in south-central Alaska's spruce forests declined in 1989 (USDA For. Serv. 1989). Only 7,000 and 10,000 acres of active infestations were detected on KNWR and the CNF, respectively. Likewise, spruce beetle activity decreased on the west side of Cook Inlet with the exception of recent activity (2,600 acres) detected along the Skwentna River north of Beluga.

MARITIME: Sitka spruce mortality increased in 1986 in the Kachemak Bay area of the Kenai Peninsula. Scattered infestations covered 3,600 acres: 1,168 acres in Mallard Bay; 1,300 acres near Bear Cove. Most of this mortality was associated with numerous pockets of blowdown. Likewise there were 500 acres of scattered spruce mortality north of Seldovia associated with logging debris left during road construction. By 1988, spruce beetle infestations increased to 10,000 acres in the Kachemak Bay area. The spruce beetle outbreak in Glacier Bay National Park in southeast Alaska increased from 12,000 to 18,000 acres (USDA For. Serv. 1986) (Fig. 2a,b).

Nearly 2,000 acres of scattered spruce have been infested during the past three years in the Yakutat Forelands. These infestations are believed to have originated in blowdown and salvage sale units. The

level of mortality in this infestation however is quite low (3-5% of the stand infested) (USDA for. Serv. 1988) (Fig. 2b).

Bark beetle populations continued to spread in the Kachemak Bay area in 1989 but declined in Glacier Bay National Park and the Yakutat Forelands (USDA For. Serv. 1989).

INTERIOR: One of the largest spruce beetle infestations to occur in interior Alaska was detected in 1986 along the Yukon River. Spruce mortality was spread along 50 miles of river and impacted 63,000 acres. This outbreak had been on-going for at least two years and more than likely originated in windthrown spruce as well as flood damaged spruce (USDA For. Serv. 1986). This outbreak impacted an additional 15,000 acres in 1987 and spread up the south fork of the Nulato River (USDA For. Serv. 1987). By 1989 this outbreak encompassed 140,000 acres with increased activity detected along the Nulato River and near the mouth of the Koyukuk River (Fig. 3).

Scattered spruce beetle infestations detected in 1988 along the Kuskokwim River continued on 10,000 acres between Sleetmute, Devil's Elbow and McGrath. Recent spruce beetle infestations were detected in 1989 southeast of McGrath along the Windy Fork and south fork of the Kuskokwim Rivers: 2,257 and 3,738 acres, respectively. The 14,000 acres of scattered spruce beetle infestations detected in 1988 approximately 30 miles southwest of the Taylor Mountains declined to low levels in 1989 (USDA For. Serv. 1989) (Fig. 3).

TABLE 1. AREAS OF SPRUCE BEETLE OUTBREAKS (IN ACRES) IN ALASKA BY GEOGRAPHIC LOCATION.

	SOUTH-CENTRAL	MARITIME	INTERIOR
1920-1940	200,000 (Copper River)	–	–
1930-1940	*1/ (Swentna R.) (Willow Crk.)	100,000 (Afognak Is.)	–
1940-1950	* (Kenai Lk.) (Knik Arm)	6,400 (Kosciusko Is.)	* (Haines Cut-off)
1950-1955	2,000 (Eklutna) 100,000 (Tlikakila R.)	200 (Dall Is.)	–
1956-1960	16,000 (CNF) 20,000 (KNMR)	2,000 (Blackstone Bay) 500 (College Fjiord)	–
1961-1965	* (Anchor Pt.) (Chitina)	* (Pr. of Wales Is.)	–
1966-1970	100 (Chickaloon R.) 39,900 (Pt.Possession) 220,000 (KNMR) 1,300 (CNF) 200 (Caribou Crk.)	200 (Salmon R.)	–
1971-1975	400 (KNMR) 60,000 (Clam Gulch) 223,000 (Tyonek) 140,000 (Beluga R.)	6,000 (Trading Bay)	–

1976-1980	16,240 (CNF-Res.Crk.) 13,000 (CNF-Summit L.) 1,000 (CNF-Up.Russ.) 47,000 (KNMR) 364,000 (Beluga Lk.)	2,000 (Taku R.) 900 (Whiting R.)	2,600 (Kusko.R.) 4,000 (Kusko.-Russ.Miss.)
1981-1985	49,291 (Susitna R.) 55,000 (KNWR) 2,560 (Anchor Pt.) 5,000 (CNF-Res.Crk.) 15,344 (Fox R.) 5,524 (Rich.Hiway) 12,484 (CNF-Cooper Ldg.) 3,523 (Ship Crk.) 3,597 (Eklutna Lk.) 31,509 (Tlikakila R.)	12,200 (Glacier Bay) 200 (Kachemak Bay)	--
1986-1989	10,000 (Ninilchik R.) 7,000 (Fort.Rich.) 18,586 (Rich.Hiway) 50,000 (KNWR) 14,000 (Kings Mtn.) 19,000 (Willow Crk.) 2,600 (Skwentna R.)	9,800 (Kachemak Bay) 5,800 (Glacier Bay) 2,000 (Yakutat)	140,000 (Yukon R.) 10,000 (Kusko.R.) 6,000 (s.f.Kusko.R.) 14,000 (Taylor Mtn.)
TOTAL	1,769,158	148,200	176,600

1/ *-infestations reported but no acreage estimates given.

APPENDIX A

SPRUCE BEETLE

Dendroctonus rufipennis (Kirby)

HOSTS: White, Sitka, Lutz, and black spruce.

DISTRIBUTION: Wherever spruce is found; a serious forest pest in south-central Alaska throughout Cook Inlet and Kenai Peninsula.

DAMAGE: Larvae feed beneath bark, usually killing affected trees.

DESRCIPTION: Adult spruce beetles are maroon to black, cylindrical in shape, approximately 5 mm long and 3mm wide. Larvae are stout, white, legless grubs, 6 mm long when full-grown. The pupae are soft-bodied, white, and have some adult features.

BIOLOGY: The life cycle of the spruce beetle may vary from one to three years, with a two-year cycle being the most common. Temperature plays an important part in determining the length of time required for beetle development.

Adult beetles become active in the spring (late May--early June) when air temperatures reach a threshold of 16o C (61o F). At this time, beetles emerge from trees in which they overwintered and fly in search of a new host material. These dispersal flights may be short-range even though beetles are capable of flying for several miles without stopping.

Spruce beetles prefer to attack the sides and bottom surfaces of windthrown or other downed materials which have been on the ground less than one year. In the absence of such host material, large-diameter live trees may be attacked instead, and if beetle populations are high, these trees may be killed.

Beetle attacks, whether on windthrown or on standing timber, are mediated by pheromones which insure that individual trees will be attacked "en masse", and fully colonized by subsequent broods. Trees that are mass-attacked form attractive centers which result in groups of trees being killed by spillover attacks.

Female beetles initiate attacks and begin constructing an egg gallery in the cambium parallel to the grain of the tree. They are joined by males and after mating, lay eggs in small niches along the sides of the egg gallery. Most eggs will hatch by August.

As they feed in the cambium, larvae construct their own galleries perpendicular to the egg gallery. Normally, spruce beetles pass the first winter in the larval stage, resume feeding the next spring, and pupate by summer. About two weeks later, pupae transform into adults which pass the second winter, either in the old pupation site, or more commonly, in the bases of infested trees. The following spring, two years after initial attack, the new adults emerge and attack new host material. In some years when temperatures are abnormally high, or on certain warmer microsites, spruce beetles may complete their development within one season and new adults will emerge one year after attack.

Most major outbreaks of spruce beetle have originated from stand disturbances -- blowdown, logging, or right-of-way clearance. Stand susceptibility to beetle attack is influenced by stocking, with slow growth and moisture stress playing an important part in predisposing trees to attack.

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